### Clinical Efficacy of Endoluminal Interventions for Below Knee Occlusive Disease

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**Background**: Endovascular therapy for below knee occlusive disease is increasingly accepted as an alternative to surgical bypass. The objectives of this study were to evaluate the overall clinical efficacy of below knee interventions and examine factors influencing their outcomes.

**Methods**: All patients with critical limb ischemia (Rutherford classes 4, 5, and 6) from 2003 to 2009 who underwent endovascular treatment of below knee arteries were selected. We identified 194 patients (72% men; mean age, 68 ± 29 years). End points evaluated were technical success, cumulative patency, reintervention rates, and limb salvage. Clinical efficacy was defined as a patient that satisfied all three criteria: vessel segment patent, patient alive, and free from major amputation. Kaplan-Meier survival analyses were performed to assess time-dependent outcomes. Factor analyses were performed using a Cox proportional hazard model for time dependent variables.

**Results**: A total of 369 below knee interventions were performed in 194 patients, of whom 71% had diabetes and 30% chronic kidney disease (estimate glomerular filtration rate <60 mL/min/1.72cm$^3$). Indications for the procedures were tissue loss in 38% and rest pain in the remainder. Single-vessel intervention was performed in 119 cases, and the rest underwent multivessel intervention. The vessels intervened on were the below knee popliteal in 31%, anterior tibial in 32%, the posterior tibial in 30%, and the peroneal in 28%. According to TransAtlantic InterSociety Consensus classification, 44% were A and B and 56% were C and D. Overall technical success rate was 88%. 30-day mortality was 1.4%, and 30-day morbidity was 19%. During a mean follow-up of 2.6 years, 12% died, 28% had occlusion of a vessel segment, 21% patients underwent amputation (17% minor, 5%, major), and 26% required two or more reinterventions. The 5-year cumulative patency was 64%. The 5-year limb salvage was 82%. Overall clinical efficacy was 75% at 1 year but only 40% at 3 years.

**Conclusions**: Endoluminal intervention for below knee vessel disease has low mortality but a high morbidity and secondary intervention rate. Clinical efficacy is good at 1 year but deteriorates rapidly by 3 years.

### Analysis of Length of Stay, Cost, and Hospital Disposition in Patients with Critical Limb Ischemia Treated with Open vs Endovascular Procedures

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**Objectives**: There has been increased emphasis on cost analysis and length of stay in hospitalized patients to analyze health care costs. Endovascular and open surgical interventions are available for the treatment of critical limb ischemia (CLI). The aim of our study was to determine if an open or endovascular procedure had a significant impact on the length of stay, discharge disposition, cost, or 90-day readmission rate to the hospital.

**Methods**: We reviewed all patients presenting with CLI from January 1, 2007 to December 31, 2007 at our institution. All patients with Rutherford class 4 or 5 disease underwent initial diagnostic evaluation with conventional arteriography and were treated with open-only, endovascular-only, or a combination of procedures based on anatomic TransAtlantic InterSociety Consensus II classification and adequate runoff. Patients were analyzed for cost of the admission, length of stay, discharge facility disposition, and readmission rate within 90 days.

**Results**: Complete data were available for 137 patients: 57 were endovascular-only, 62 were open-only, and 18 were a combination of both. The mean length of stay was 9.3 ± 8.66 days for the endovascular group, 10.4 ± 7.89 days for the open group, and 9.8 ± 6.45 days for the hybrid group. Of patients undergoing an open procedure, 44% were discharged to a skilled nursing facility or rehabilitation center compared with 35% of endovascular-only patients and 28% of hybrid patients. The mean cost hospitalization of an open procedure was $45,832 ± $23,053 compared with $49,802 ± $27,657 in endovascular-only and $27,922 ± $10,053 in the hybrid procedure patients. The readmission rate for the endovascular group was 12% compared with 13% for the open group and 50% for the hybrid group.

**Conclusions**: Patients presenting with CLI have shorter lengths of stay if they undergo an endovascular-only procedure; however, longer admissions are also possible. Hospitalization costs of patients undergoing an open-only or endovascular-only approach are similar, with similar rates of readmission. An open bypass procedure, however, places patients at a greater chance being discharged to a skilled nursing facility. Overall, endovascular treatment does not offer a cost-saving advantage over open surgical reconstruction; however, these patients are more likely to recover function for home placement upon discharge.

### Functional Outcomes of Revascularization for Critical Limb Ischemia

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**Objectives**: Outcome measures of revascularization for critical limb ischemia (CLI) have historically been patency, survival, and amputation. Functional status and quality of life (QOL) assessments have not been well described. This study used functional assessments and QOL questionnaires to measure patient-centered outcomes after revascularization for CLI.

**Methods**: Eighteen patients (mean age, 65 ± 11 years) were monitored prospectively before and after lower extremity bypass for CLI. Muscle strength was assessed preoperatively and postoperatively with tests of knee and flexion, ankle dorsiflexion, ankle plantar flexion, elbow and extension, and handgrip for ipsilateral and contralateral limbs using the Muscle Function Evaluation chair (MFEC). Patients completed the Short Physical Performance Battery (SPPB), which measures walking speed, leg strength, and balance, a 6-minute walk, and caloric expenditure with an accelerometer. QOL instruments included the Short Form 36 (SF-36), Vascular Quality of Life (VascuQol).

**Results**: Ankle-brachial indices (ABI) in the ipsilateral leg increased 0.46 ± 0.17 (mean ± SD) to 0.88 ± 0.21 ($P < .001$). Mean follow-up was 121 ± 57 days. MFEC measurements of ipsilateral leg strength demonstrated knee flexion increase from 64 ± 63 to 135 ± 133 N ($P = .038$). Knee extension increased from 120 ± 110 to 186 ± 85 N, which approached significance ($P = .062$), as did ankle plantar flexion, which increased from 178 ± 126 to 267 ± 252 N ($P = .078$). In the contralateral leg, knee flexion increased from 71 ± 96 to 149 ± 162 N ($P = .028$), and knee extension increased from 162 ± 112 to 239 ± 158 N ($P = .036$). Nearly all upper extremity strength measurements showed an absolute decrease postoperatively, but this change was not significant. Absolute improvements were noted in 6-minute walk distance, daily caloric expenditure, and in individual domains and overall SPPB scores, although none were significant. The VascuQol captured the most significant QOL improvement in individual domains, and overall score ($P < .015$ for each domain). Significant improvement was noted only for Body Pain ($P = .011$) using the SF-36.

**Conclusions**: Revascularization for CLI results in improved muscle strength, leg function, and patient-perceived function using a disease-specific questionnaire (VascuQol). Decline in upper extremity strength and unimproved SF-36 domain scores suggest an overall deconditioning after revascularization despite leg improvements.

### Clinical Efficacy of Concomitant Tibial Interventions Associated With SFA Interventions in Critical Limb Ischemia

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**Background**: Combined superficial femoral artery (SFA) and tibial interventions are commonplace in the treatment of critical limb ischemia. Poor tibial runoff significantly compromises the durability and clinical effectiveness of SFA interventions. The aim of this study was to determine the clinical and anatomic outcomes of SFA interventions in patients with equally compromised runoff with and without concomitant tibial angioplasty (TA).

**Methods**: A database of patients undergoing endovascular treatment of the SFA arteries between 1999 and 2009 was retrospectively queried. Only patients with poor runoff, defined by a runoff score >10 were selected. Preoperative angiograms were reviewed to assess distal popliteal and tibial runoff and were scored according to modified Society for Vascular Surgery criteria for both vessels such that a higher score implies worse runoff (minimum 1; maximum, 19). Kaplan-Meier survival analyses were performed to assess time-dependent outcomes. Factor analyses were performed using a Cox proportional hazard model for time-dependent variables.

**Results**: A total of 195 limbs with a runoff score >10 (64% male; average age, 67 years) underwent endovascular treatment for symptomatic SFA; of whom, 33% underwent TA, while the remainder did not. The groups were matched for age, gender, and SFA anatomy; however the presenting symptoms were worse in the TA group. Anatomic outcomes were equivalent, but freedom from recurrent symptoms and limb salvage were worse in the TA group (Table).

**Conclusions**: TA in poor runoff patients has no effect on SFA anatomic outcomes. Clinical efficacy, as determined by freedom from recurrent symptoms, and limb salvage was worse after concomitant TA and was driven by the presence of critical limb ischemia. Concomitant TA appears not to add significant benefit to SFA in critical limb ischemia.

**Table.**

| *Variable* | *No TA* | *TA* | P |
|---|---|---|---|
| Limbs at risk, No. | 128 | 64 | — |
| Gender (%) | 51 | 71 | .16 |
| Age, mean ± SD, yrs | 69 ± 16 | 69 ± 14 | .1 |
| Rest pain/tissue loss, % | 71 | 94 | .0001[a] |
| TASC C and D lesions, % | 50 | 61 | .17 |
| Mortality, % | 0.8 | 0.0 | .1 |
| Morbidity, % | 9.4 | 9.4 | .1 |
| Outcomes at 5 years, % | | | |
| Freedom from recurrent symptoms | 78 | 70 | .04[a] |
| Limb salvage | 78 | 69 | .04[a] |
| Primary patency | 59 | 55 | .84 |
| Assisted primary patency | 69 | 79 | .33 |
| Secondary patency | 71 | 79 | .33 |

[a]Statistically significant

**Treatment of Type II Endoleaks: Coil Embolization of Lumbar Vessels Has Poor Long-Term Success**

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**Introduction**: The significance of type II endoleak after EVAR is still controversial. The lack of data for outcomes of intervention in attempts to seal the leak only obfuscates the issue. The effectiveness and durability of interventions are important in understanding the meaning of type II endoleaks. The purpose of this study was to examine outcomes after interventions for type II endoleaks in our institution.

**Methods**: We evaluated patients who underwent type II endoleak treatment at our tertiary care facility from 2001 to 2009. Through aggressive surveillance imaging, 29 patients showed aneurysm enlargement and type II endoleak. All patients underwent at least one attempt at percutaneous intervention. Patients were followed-up postoperatively, both clinically and radiographically, with a CT angiogram every 3 to 12 months. The outcomes of patients with expanding type II endoleaks after intervention were analyzed. The mean postprocedural follow-up was 3.5 years (range, 1-10 years).

**Results**: A total of 48 interventions on 29 patients (22 men, 7 women; mean age, 76; range 54-87 years) were performed. Of these, 15 patients (56%) underwent multiple procedures (≥2): 9 (31%) underwent two, 5 (17%) had three, and 1 (3.4%) had four separate attempts at treatment. Three ultimately required elective aortic graft explants. There were no ruptures in these patients during the time they were followed-up. Seven patients (24%) had continued endoleak despite multiple treatment attempts. Of the treatment modalities used, lumbar embolization was the least successful, with an 82% failure/recurrence rate. Conversely, IMA coil embolization had the highest success rate (Table). Three patients had minor complications (hematoma and wound infection). There were no deaths in this cohort.

**Conclusions**: Although initial success is often documented immediately angiographically, as well as in the short-term, long-term outcomes for intervention on type II endoleak remain unknown. This study demonstrates that most patients require multiple reinterventions to treat type II endoleaks, and specifically, lumbar embolization carries a low long-term success rate.

**Carotid Stenting: The Data of Transcranial Doppler, Cognitive Tests, and DWI-MR May Influence Results?**

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**Objectives**: The purpose of this study was to determine the significance of microembolic signals (MES) recorded with transcranial Doppler (TCD) during carotid artery stenting (CAS). This study was based on analysis of TCD data compared both with changes induced on the brain identified by diffusion-weighted magnetic resonance imaging (DWI-MR) and with potential neurologic impairment assessed by clinical examination and cognitive tests.

**Methods**: From January 2007 to December 2009, 152 patients underwent CAS: 112 were asymptomatic (73.8%) and 40 were symptomatic (26.2%). As assessed by duplex scanning, all carotid stenosis were hemodynamically significant and plaques had echomorphologic features of stability. A CAS was successfully done in 150 patients (98.7%). Cerebral protection filter devices were used in all patients. Before the procedure, 60 minutes of TCD monitoring was performed to detect MES in order to exclude embolic plaques. TCD monitoring was carried out throughout the procedures and for 60 minutes after. In all patients, neurologic examination associated to cognitive tests and DWI-MR were carried out preoperatively and postoperatively. Statistical analysis was performed by means the binomial test ($P = .50$) and the Fischer exact test.

**Results**: There were no deaths. Five minor stokes occurred during the procedure, and all were related to ≥40 MES; one major stroke was observed postoperatively. Fewer than 40 MES were recorded in 97 cases; in this group, postoperative DW-MRI showed new ischemic lesions in 18 (18.5%, $P = .0009$). In 48 patients was recorded MES ≥40 either during catheterization of carotid arteries and during cerebral protection filter placement (27 patients, group A) or during stent placement and ballooning (21 cases, group B). Postoperative DW-MRI showed new ischemic lesions in 21 of 27 patients of group A and in all patients of group B, with a statistically significant correlation. Comparison of MRI data with those of cognitive tests showed a statistical significant correlation between DWI lesions and postoperative cognitive impairment ($P = .00001$). Symptomatic patients suffering from minor or major strokes had DW-MRI lesions >20 mm$^2$.

**Conclusions**: Our data suggest that even in selective patients undergoing CAS, when intraprocedural TCD records ≥40 MES during stent deployment, there is a high odds ratio new ischemic lesions will develop as detected by DW-MRI, combined with postprocedural cognitive impairment.

**A National Survey of The Use of Anti-Platelet Medications and Protamine During Carotid Endarterectomy and Carotid Artery Stenting: What Is the Standard?**

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**Objectives**: The use of anticoagulation during carotid endarterectomy (CEA) and carotid artery stenting (CAS) has been standard practice for many years. However, reversal with protamine sulfate has not been a formally standardized process. In our study, we assessed the anticoagulation therapies most commonly used before, during, and after these procedures. In addition, we evaluated the percentage of vascular surgeons that perform carotid artery interventions.

**Methods**: Members of the Society of Vascular Surgery were sent an e-mail survey by Survey Monkey with 16 multiple-choice questions about CEA and CAS anticoagulation management. The questions addressed the choices of antiplatelet therapy before the procedure, assessment of platelet inhibition before the procedure, anticoagulation therapy during the proce-

**Table.** Outcomes based on endoleak intervention

| *Initial intervention* | *Success* | *Failure* | *Secondary intervention* | *Success* | *Failure* | *Subsequent interventions* | *Success* | *Failure* |
|---|---|---|---|---|---|---|---|---|
| IMA embolization | 8 | 3 | Lumbar embolization | 1 | | | | |
| | | | IMA embolization | 1 | | | | |
| Lumbar embolization | 3 | 14 | Lumbar embolization | 2 | 3 | Lumbar embolization | 2 | 4 |
| | | | Laparoscopic ligation | 1 | 2 | Explant | 1 | |
| | | | Explant | 1 | | | | |
| | | | Thrombin gel | 1 | | | | |
| | | | IMA embolization | 1 | | | | |
| Laparoscopic ligation | 0 | 1 | Explant | 1 | | | | |